innodisk

Total Solution For
Industrial Flash Storage

mSATA

3SE3 Series

Customer: _____

Customer Part Number: _____

Innodisk Part Number: _____

Innodisk Model Name: _____

Date: _____

Innodisk Approver	Customer Approver

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REVISION HISTORY

Revision	Description	Date
Preliminary	First Released	Aug,2016
1.0	Official released	Sep., 2016
1.1	Add 4/8/16GB Model with Kioxia 24nm SLC NAND	Jan., 2020
1.2	Update Reliability	Aug., 2024

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1. Product Overview

1.1 Introduction of Innodisk mSATA 3SE3

Innodisk mSATA 3SE3 is designed with mSATA form factor by MO-300/MO-300B which established by JEDEC, and supports SATA III standard (6.0 Gb/s) with excellent performance. Regarding of mechanical interference, Innodisk mSATA 3SE3 absolutely replaces the traditional hard disk and makes personal computer, in any field, smaller and easier.

Innodisk offers SLC series of product with SLC-based flash, boasting faster write speeds and lower consumption, is more reliable and suitable of critical applications.

Innodisk mSATA 3SE3 effectively reduces the booting time of operation system and the power consumption is less than hard disk drive (HDD), and complies with ATA protocol, no additional drives are required, and can be configured as a boot device or data storage device

1.2 Product View and Models

Innodisk mSATA 3SE3 is available in follow capacities within SLC flash ICs.

mSATA 3SE3 4GB mSATA 3SE3 8GB mSATA 3SE3 16GB
mSATA 3SE3 32GB mSATA 3SE3 64GB mSATA 3SE3 128GB

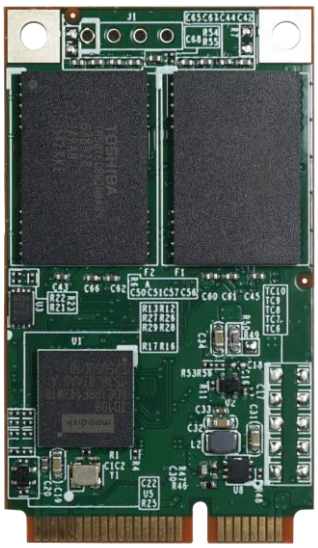


Figure 1: Innodisk mSATA 3SE3

1.3 SATA Interface

Innodisk mSATA 3SE3 supports SATA III interface, and compliant with SATA I and SATA II. SATA III interface can work with Serial Attached SCSI (SAS) host system, which is used in server computer. Innodisk mSATA 3SE3 is compliant with Serial ATA Gen 1, Gen 2 and Gen 3 specification (Gen 3 supports 1.5Gbps /3.0Gbps/6.0Gbps data rate).

2. Product Specifications

2.1 Capacity and Device Parameters

mSATA 3SE3 device parameters are shown in Table 1.

Table 1: Device parameters

Capacity	Cylinders	Heads	Sectors	LBA	User Capacity(MB)
04GB	7773	16	63	7835184	3,826
08GB	15525	16	63	15649200	7,641
16GB	16383	16	63	31277232	15,272
32GB	16383	16	63	62533296	30,533
64GB	16383	16	63	125045424	61,057
128GB	16383	16	63	250069680	122,104

2.2 Performance

Burst Transfer Rate: 6.0Gbps

Table 2: Performance

Capacity	4GB	4GB 24nm	8GB	8GB 24nm	16GB	16GB 24nm	32GB	64GB	128GB
Sequential Read (max.)	120 MB/sec	31 MB/sec	220 MB/sec	62 MB/sec	385 MB/sec	123 MB/sec	380 MB/sec	385 MB/sec	385 MB/sec
Sequential Write (max.)	55 MB/sec	26 MB/sec	110 MB/sec	50 MB/sec	170 MB/sec	96 MB/sec	210 MB/sec	225 MB/sec	220 MB/sec
4KB Random** Read (QD32)	6,100 IOPS	3,500 IOPS	9,900 IOPS	5,500 IOPS	13,000 IOPS	8,500 IOPS	13,000 IOPS	12,000 IOPS	12,000 IOPS
4KB Random** Write (QD32)	10,000 IOPS	6,000 IOPS	15,000 IOPS	8,500 IOPS	18,000 IOPS	10,500 IOPS	20,000 IOPS	20,000 IOPS	20,000 IOPS

Note: the information is based on CrystalDiskMark 5.1.2 with file size 1000MB test patent

2.3 Electrical Specifications

2.3.1 Power Requirement

Table 3: Innodisk mSATA 3SE3 Power Requirement

Item	Symbol	Rating	Unit
Input voltage	V_{IN}	+3.3 DC +- 5%	V

2.3.2 Power Consumption

Table 4: Power Consumption

Mode	Power Consumption (mA)
Read	174 (max.)
Write	180 (max.)
Idle	134 (max.)

* Target: 128GB mSATA 3SE3

2.4 Environmental Specifications

2.4.1 Temperature Ranges

Table 5: Temperature range for mSATA 3SE3

Temperature	Range
Operating	Standard Grade: 0°C to +70°C
	Industrial Grade: -40°C to +85°C
Storage	-55°C to +95°C

2.4.2 Humidity

Relative Humidity: 10-95%, non-condensing

2.4.3 Shock and Vibration

Table 6: Shock/Vibration Testing for mSATA 3SE3

Reliability	Test Conditions	Reference Standards
Vibration	7 Hz to 2K Hz, 20G, 3 axes	IEC 60068-2-6
Mechanical Shock	Duration: 0.5ms, 1500 G, 3 axes	IEC 60068-2-27

2.4.4 Mean Time between Failures (MTBF)

Table 7 summarizes the MTBF prediction results for various mSATA 3SE3 configurations. The analysis was performed using a RAM Commander™ failure rate prediction.

- **Failure Rate**: The total number of failures within an item population, divided by the total number of life units expended by that population, during a particular measurement interval under stated condition.
- **Mean Time between Failures (MTBF)**: A basic measure of reliability for repairable items: The mean number of life units during which all parts of the item perform within their specified limits, during a particular measurement interval under stated conditions.

Table 7: mSATA 3SE3 MTBF

Product	Condition	MTBF (Hours)
Innodisk mSATA 3SE3	Telcordia SR-332 GB, 25°C	>3,000,000

2.5 CE and FCC Compatibility

mSATA 3SE3 conforms to CE and FCC requirements.

2.6 RoHS Compliance

mSATA 3SE3 is fully compliant with RoHS directive.

2.7 Reliability

Parameter	Value
Read Cycles	Unlimited Read Cycles
Flash endurance	60,000 P/E cycles
Wear-Leveling Algorithm	Support
Bad Blocks Management	Support
Error Correct Code	Support
Data Retention	Under 40℃: 1 Year at NAND Life End
TBW* (Total Bytes Written) Unit:TB	
04GB	24
08GB	48
16GB	96
32GB	192
64GB	384
128GB	768
* Total bytes written is based on JEDEC 218 (Solid-State Drive Requirements and Endurance Test Method)	

2.8 Transfer Mode

mSATA 3SE3 support following transfer mode:

Serial ATA III 6.0Gbps

Serial ATA II 3.0Gbps

Serial ATA I 1.5Gbps

2.9 Pin Assignment

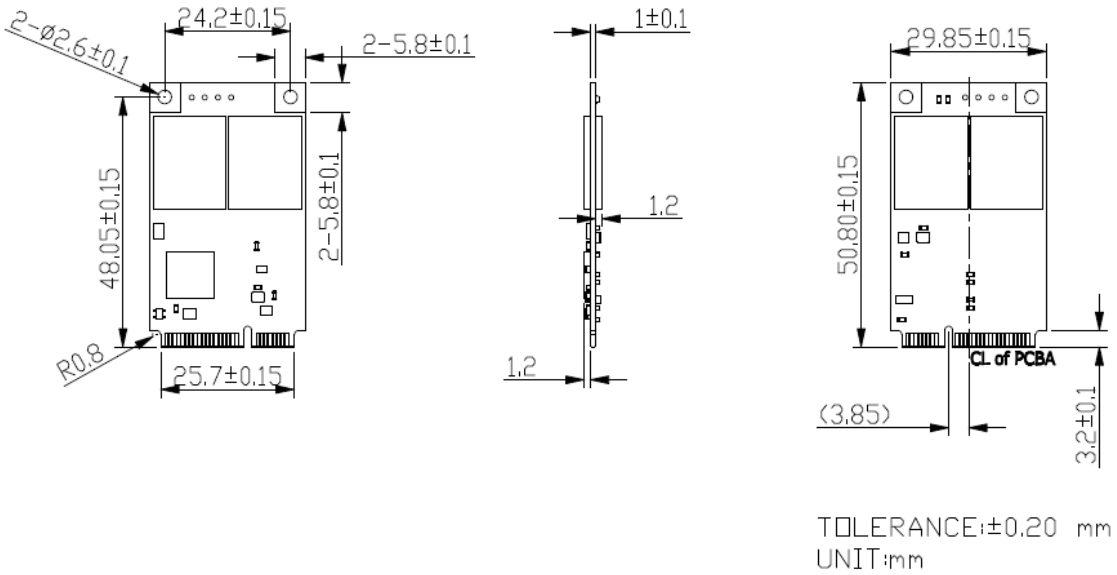
Innodisk mSATA 3SE3 uses a standard SATA pin-out. See Table 8 for mSATA 3SE3 pin assignment.

Table 8: Innodisk mSATA 3SE3 Pin Assignment

Signal Name	Pin #	Pin #	Signal Name
GND	51	52	+3.3V
DAS	49	50	GND
NC	47	48	NC
NC	45	46	NC
NC	43	44	NC
+3.3V	41	42	NC
+3.3V	39	40	GND

GND	37	38	NC
GND	35	36	NC
RX+	33	34	GND
RX-	31	32	NC
GND	29	30	NC
GND	27	28	NC
TX-	25	26	GND
TX+	23	24	+3.3V
GND	21	22	NC
NC	19	20	NC
NC	17	18	GND
GND	15	16	NC
NC	13	14	NC
NC	11	12	NC
GND	9	10	NC
NC	7	8	NC
NC	5	6	NC
NC	3	4	GND
NC	1	2	+3.3V

2.10 Mechanical Dimensions



2.11 Assembly Weight

An Innodisk mSATA 3SE3 within flash ICs, 32GB's weight is 8 grams approximately.

2.12 Seek Time

Innodisk mSATA 3SE3 is not a magnetic rotating design. There is no seek or rotational latency required.

2.13 NAND Flash Memory

Innodisk mSATA 3SE3 uses Multi Level Cell (SLC) NAND flash memory, which is non-volatility, high reliability and high speed memory storage. Each cell stores 2 bits or holds four states per cell. Read or Write data to flash memory for SSD is control by microprocessor.

3. Theory of Operation

3.1 Overview

Figure 2 shows the operation of Innodisk mSATA 3SE3 from the system level, including the major hardware blocks.

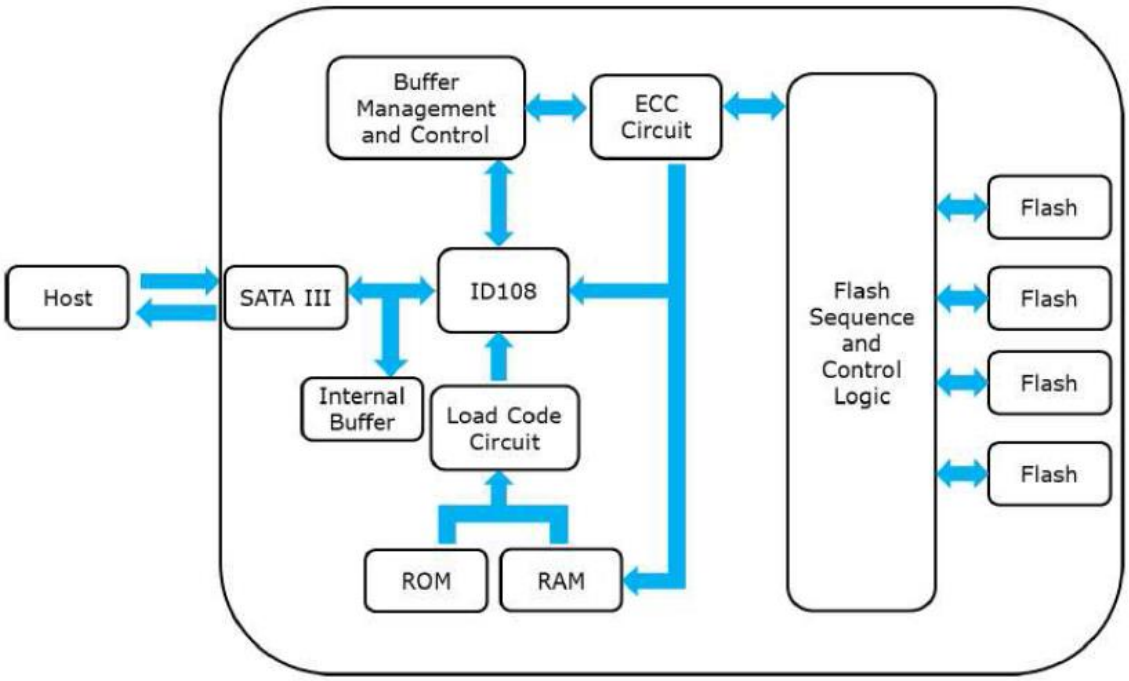


Figure 2: Innodisk mSATA 3SE3 Block Diagram

Innodisk mSATA 3SE3 integrates a SATA III controller and NAND flash memories. Communication with the host occurs through the host interface, using the standard ATA protocol. Communication with the flash device(s) occurs through the flash interface.

3.2 SATA III Controller

Innodisk mSATA 3SE3 is designed with ID108, a SATA III 6.0Gbps (Gen. 3) controller. The Serial ATA physical, link and transport layers are compliant with Serial ATA Gen 1, Gen 2 and Gen 3 specification (Gen 3 supports 1.5Gbps/3.0Gbps/6.0Gbps data rate). The controller has 4 channels for flash interface.

3.3 Error Detection and Correction

Highly sophisticated Error Correction Code algorithms are implemented. The ECC unit consists of the Parity Unit (parity-byte generation) and the Syndrome Unit (syndrome-byte computation). This unit implements an algorithm that can correct 40 bits per 1024 bytes in an ECC block. Code-byte generation during write operations, as well as error detection during read operation, is implemented on the fly without any speed penalties.

3.4 Wear-Leveling

Flash memory can be erased within a limited number of times. This number is called the ***erase cycle limit*** or ***write endurance limit*** and is defined by the flash array vendor. The erase cycle limit applies to each individual erase block in the flash device.

Innodisk mSATA 3SE3 uses a static wear-leveling algorithm to ensure that consecutive writes of a specific sector are not written physically to the same page/block in the flash. This spreads flash media usage evenly across all pages, thereby extending flash lifetime.

3.5 Bad Blocks Management

Bad Blocks are blocks that contain one or more invalid bits whose reliability are not guaranteed. The Bad Blocks may be presented while the SSD is shipped, or may develop during the life time of the SSD. When the Bad Blocks is detected, it will be flagged, and not be used anymore. The SSD implement Bad Blocks management, Bad Blocks replacement, Error Correct Code to avoid data error occurred. The functions will be enabled automatically to transfer data from Bad Blocks to spare blocks, and correct error bit.

3.6 Power Cycling

Innodisk's power cycling management is a comprehensive data protection mechanism that functions before and after a sudden power outage to SSD. Low-power detection terminates data writing before an abnormal power-off, while table-remapping after power-on deletes corrupt data and maintains data integrity. Innodisk's power cycling provides effective power cycling management, preventing data stored in flash from degrading with use.

3.7 Garbage Collection

Garbage collection is used to maintain data consistency and perform continual data cleansing on SSDs. It runs as a background process, freeing up valuable controller resources while sorting good data into available blocks, and deleting bad blocks. It also significantly reduces write operations to the drive, thereby increasing the SSD's speed and lifespan.

3.8 Trim

The Trim command is designed to enable the operating system to notify the SSD which pages no longer contain valid data due to erases either by the user or operating system itself. During a delete operation, the OS will mark the sectors as free for new data and send a Trim command to the SSD to mark them as not containing valid data. After that the SSD knows not to preserve the contents of the block when writing a page, resulting in less write amplification with fewer writes to the flash, higher write speed, and increased drive life.

4. Installation Requirements

4.1 mSATA 3SE3 Pin Directions

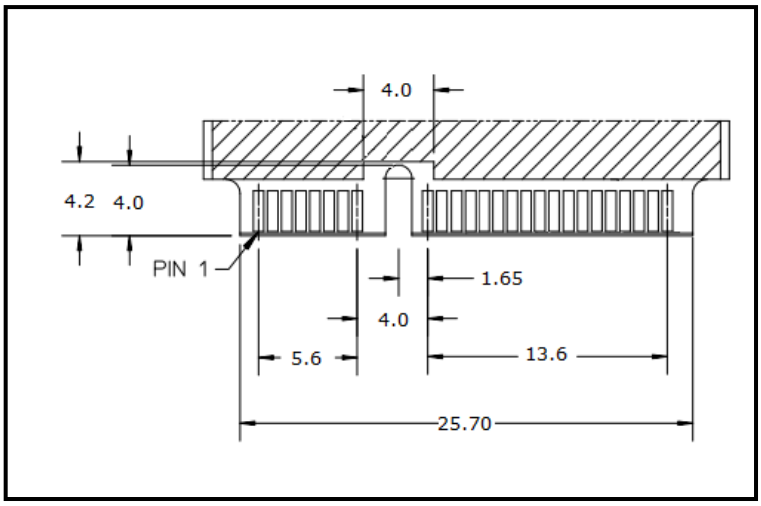


Figure 3: Signal Segment and Power Segment

4.2 Electrical Connections for mSATA 3SE3

A Serial ATA device may be either directly connected to a host or connected to a host through an adaptor card. The SATA interface has a separate connector for the power supply. Please refer to the pin description for further details.

4.3 Device Drive

No additional device drives are required. The Innodisk mSATA 3SE3 can be configured as a boot device.

5. Part Number Rule

CODE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	D	**E**	**M**	**S**	**R**	**-**	**3**	**2**	**G**	**D**	**0**	**8**	**S**	**C**	**A**	**D**	**B**	**-**	**X**	**X**	**X**

Definition	
Code 1st (Disk)	**Code 13th (Flash Mode)**
D : Disk	A: Asynchronous Flash
	S: Synchronous Flash
Code 2nd ~ 5th (Form Factor)	**Code 14th (Operation Temperature)**
EMSR: mSATA Regular	C: Standard Grade (0℃~ +70℃)
Code 7th ~9th (Capacity)	W: Industrial Grade (-40℃~ +85℃)
04G: 4GB	**Code 15th (Internal control)**
08G: 8GB	A~Z: BGA PCB version
16G: 16GB	1~9: TSOP BCB version
32G: 32GB	**Code 16th (Channel of data transfer)**
64G: 64GB	S: Single Channel
A28: 128GB	D: Dual Channels
	Q:Quad Channels
Code 10th ~12th (Controller)	**Code 17th (Flash Type)**
D08: ID108	B: Toshiba SLC
	Code 19th~21th (Customized Code)